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ABSTRACT

The subjects in this study of the feasibility of computer assisted instruction at the elementary level were 12 educable mentally retarded (EMR) children and 12 normal children, judged to be relatively equivalent in mental age and development level. The experimental group, consisting of both EMR and normal subjects, participated in a programed vocabulary sequence. All subjects were given a posttest. For subjects of comparable mental age there were no significant differences between EMRs and normals in learning, error rate, or time necessary for completion of the learning sequence. In the experimental group, learning was found to be negatively correlated with mental age of EMRs, but error rate was not related to mental age. Finally, there were significant differences in the positive direction between the posttest scores of experimental and control subjects. Further investigation using older subjects and more sophisticated equipment over longer time periods is recommended. (WDR)

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RESEARCH REPORT #7322
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AN EVALUATION OF COMPUTER ASSISTED VOCABULARY INSTRUCTION WITH MENTALLY RETARDED CHILDREN

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ABSTRACT

The purpose of this study was to ascertain the feasibility of using computer assisted instruction with elementary level educable mentally retarded (EMR) children. The subjects were 12 EMR and 12 normal children, judged to be relatively equivalent in mental age and developmental level. The experimental group, consisting of both EMR and normal subjects, participated in a programmed vocabulary sequence, and were given a posttest. The control group was administered the posttest only. The results indicated that, for Ss of comparable mental age, there were no significant differences between EMR and normal Ss in: (1) learning, (2) error rate, and (3) time necessary for completion of the sequence. A negative correlation was found to exist between mental age of EMR Ss and learning in the experimental group. However, mental age of EMR Ss was not found to be related to error rate on the vocabulary sequence. Finally, significant differences were found between the posttest scores of experimental and control subjects. The author recommends further investigation using older Ss and more sophisticated equipment.

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SPECIAL REPORT No.7322
COMPUTER-BASED PROJECT for the EVALUATION of MEDIA for the HANDICAPPED

Title: AN EVALUATION OF COMPUTER ASSISTED VOCABULARY INSTRUCTION WITH MENTALLY RETARDED CHILDRE'.

BY: Edwina M. Nelon

BACKGROUND

The Computer Based Project for the Evaluation of Media for the Handicapped, based on contract #OEC-9-423617-4357 (616) between the Syracuse (N.Y.) City School District and the Media Services and Captioned Films Branch, Bureau of Education for the Handicapped (United States Office of Education) for the five year period July 1, 1969 through June 30, 1974. The major goal is to improve the instruction of handicapped children through the development and use of an evaluation system to measure the instructional effectiveness of films and other materials with educable mentally handicapped (EMH) children, in-service training and media support for special teachers, and studies related to the evaluation process and the populations used.

The Project has concentrated on the 600 films and 200 filmstrips from the Media Services and Captioned Films (BEH - USOE) depository; however, specific packages from Project LIFE, various elementary math curricula, and selected programs from Children's TV Workshop have also been evaluated. The evaluation model used requires that: 1) objectives of materials be specified and written; 2) instruments be constructed to test and measure effectiveness; and, 3) children be the major sources of evaluation information. A number of instruments and methodologies are employed in the gathering of cognitive and affective data from 900 EMH children and 80 special teachers to make the effectiveness decisions. Over half of the EMH population can neither read or write; therefore, a unique Student Response System (SRS) is employed, consisting of a twenty station G.E.-1000 SRS which can be operated in a group or individual recording mode and is connected to a remote computer system. The computer capabilities consist of remote telephone connections to the Rome (N.Y.) Air Development Command, the Honeywell time-shared network, and the Schenectady (N.Y.) G E Research and Development Center; and batch mode capabilities of the Syracuse City Schools, Syracuse University, and various commercial sources.

In-service and media support activities provide on-the-job training for teachers, teacher aides, equipment, and materials to the special teachers in the city schools. The research activities have centered around investigations and special problems related to the development of the evaluation model. The four major areas considered are: 1) testing effects, 2) captioning effects, 3) special student characteristics; and, 4) evaluation procedures validation.

Documentation of the major activities appear in the five annual reports and the 600 evaluations prepared on materials used. Staff members were encouraged to prepare special reports and the attached paper is one of these. The opinions expressed in this publication do not necessarily reflect the position or policy of the Computer Based Project, the United States Office of Education, or the Syracuse City School District, and no official endorsement by any of the agencies should be inferred.

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AN EVALUATION OF COMPUTER ASSISTED VOCABULARY INSTRUCTION WITH MENTALLY RETARDED CHILDREN

Introduction

The use of computers in the field of education as tools to aid in the effectiveness and efficiency of instruction has been widely investigated during the last decade. Computer applications in education range from situations in which the computer system serves simply as a record keeper, performing largely clerical tasks, to networks where the system interacts with students, tutoring them according to personal needs, monitoring their performance and adjusting their curriculum accordingly. The bulk of the literature evaluating these various applications shows comparable, and in some cases, greater effectiveness than the performance of the same functions manually (Hickey, 1969). In record keeping and clerical functions such as report card and class schedule generation, the use of the computer seems quite justified in terms of efficiency and cost effectiveness. The performance of the computer in tutorial capacities has been found to be at least equivalent and in a few systems, better, than that of a human teacher. However, in terms of cost effectiveness, the tutorial application of the computer can only be justified at the college level where the per hour cost of instruction begins to be comparable to that of the computer (Kopstein and Seidel, 1967). An exception to this situation is found

with the PLATO system at the University of Illinois where their per hour costs for instruction are presently at $0.70/hr. and this figure is rapidly declining to the desired level of $0.50. This system is enormously large. however, and though it is probably the most advanced of its kind in the world, the system is not typical at the moment of the average computer assisted instruction setup.

One of the major causes of the unfavorable cost comparisons at lower educational levels is that greater numbers of students are taught by one teacher. Situations where a low number of students per teacher are the norm quickly become comparable, economically, with the use of computer assisted instruction.

The Problem

This study sought to investigate the feasibility of the use of computer assisted instruction with mentally retarded children. The instructional environment of mentally retarded children in terms of children per teacher is such that the use of a computer is reasonable in terms of cost, but there is insufficient data on whether or not the use of the computer can be justified in terms of instructional effectiveness. Mentally retarded children generally require more personal instruction from their teachers than do normal children, often to the extent of being incapable of studying on their own. This results in teachers performing a great deal of simple drill instruction when their talent and creativity could be better applied to overall problem solving and interactions on a creative level. The use of an interactive

computer system to perform the everyday drill and practice tasks could free the teacher for better uses of her capabilities.

Fundamental vocabulary instruction and drill is one logical area of application of the computer in early elementary education. Considerable research by Malpass (1963) on the use of programmed teaching machines for vocabulary instruction with mentally retarded children has shown generally positive findings concerning the use of teaching machines as compared to traditional teaching methods. It is conceivable that the teaching machine results would generalize to computer assisted instruction situations, and it is on that premise that this study is based. Therefore, evaluation of the use of an interactive computer assisted programmed instruction sequence which teaches recognition and spelling of approximately 15 of the 300 most often occurring non-nouns was performed. These words were among basic vocabulary items taught at the first grade level and subjects for this study were both at this grade level (as measured by mental age and performance) and at slightly older and younger levels. Normal children also went through the programmed instruction sequence and their scores aided in giving perspective to the findings regarding the mentally retarded children. It is hoped that the findings of this study will be of use in establishing sets of norms with regard to this method of instruction, and aid in more extensive evaluation projects.

It was posited that after completing the programmed instruction sequence there would be no difference between the learning of the

vocabulary words, as measured by a posttest score, between matched (mental age) groups of mentally retarded children and normal children. It was expected that there would be a significant difference between the two groups in terms of length of time necessary to complete the sequence and the error rate for the sequence. The mentally retarded group and the normal group included students of various mental ages and it was expected that there would be a significant relationship between mental age and performance on the vocabulary sequence as measured by posttest score, error rate, and time necessary to complete the sequence.

Students in all experimental groups, including the control group completed a preliminary sequence during which they were taught, using a programmed interactive method, how to type and spell their name. This introductory sequence served to familiarize the students with the terminal environment and also served to introduce cuing and reinforcing statements used in the vocabulary sequence.

Because this study did not include as a control group a class being taught the same vocabulary material by traditional methods, comparative data on whether the computer assisted vocabulary instruction is as effective as classroom teachers will not be available. However, the major purpose of this study was to obtain an overall view of the feasibility of the use of this method with mentally retarded children on the early elementary level, and research providing comparative data would be the logical next step.

Review of the Literature

Literature pertaining to this study comes from two areas which at the moment have little or no common ground. The first is the area of the education of the mentally retarded; the second is the field of computer assisted instruction. Research in the education of the mentally retarded child comes closest to research on computer assisted instruction in studies dealing with the uses of programmed instruction and teaching machines with mentally retarded children. Literature pertaining to programmed instruction for retarded children will be reviewed first, and a brief survey of the uses of computer assisted instruction with children of the same age range as those participating in this study will follow.

1. Programmed instruction and the mentally retarded.

The main characteristics of teaching machines and programmed instruction are the active participation of the pupil, the immediate feedback, an optimal sequential order of material, and the finely graded steps provided to insure mastery of the material (Blackman and Capobianco, 1965). There have been criticisms of programmed instruction on the grounds that it does not provide opportunities to solve problems creatively; however Fitzgibbon (1962) maintains that programmed instruction is capable of going beyond mere skills and basic knowledge to involving the use of these skills and concepts in social situations.

Stolurow (1963) has been an ardent advocate of programmed instruction for the mentally retarded. Because sufficient normative data based

on alternative methods of instruction are lacking, he admits that it has been impossible to make quantitative comparisons with other methods of instruction. He asserts, however, that the relative efficiency of programmed instruction is a less important issue in the education of children of average and superior intellectual status since the mentally retarded. especially those who are institutionalized, often have minimum educational opportunities. Hence, any effective method, especially if it does not require a great deal of individual teacher interaction, is helpful.

During the past several years, Moore (1964) has been employing "talking typewriters" as a means of teaching reading to pre-school children. He has also suggested that his responsive environment provides a fruitful learning situation for the educable mentally handicapped. The responsive environment includes individual booths with elaborate fully or partially automated typewriters, booth monitors and tape recorders. The primary focus is on the "talking typewriter". A child is permitted to play or work with the typewriter for a 30 minute period. The first stage of instruction is the free exploration stage, during which the child is permitted to strike keys at random. In the second stage, which is instigated when the booth monitor determines the child is ready for more challenge, the child discovers that he must strike only those letters shown in the rectangular window of the machine. The machine is programmed so that these are the only letters which can be depressed. When the child reaches the point where

he no longer must search for designated letters, he moves to stage three of instruction, the word construction stage. The last phase of the program consists of reading and writing, with more latitude provided for individual typing and reading rates. Moore cites case studies of three educable mentally retarded children benefiting from this approach. The more dramatic of these studies concerned twin girls in the low educable IQ range who had been excluded from kindergarten for lack of speech. After approximately a year in the responsive environment, their speech increased markedly and they were able to read in first grade primers.

Programmed instruction may, in some cases, be more efficient time wise than traditional methods. Price (1963) found that, with groups of children learning subtraction, using either machine or conventional instruction produced significant achievement. However, for an equivalent amount of material covered, the amount of time spent by pupils in the programmed instruction class was 86 hours as compared to 130 hours for the conventional class.

A study by Malpass (1963) established conclusively that retarded children can acquire and retain knowledge of common words presented under automated instruction. Significant differences occurred between gain scores of children taught by either of two types of teaching machines and by conventional methods, in favor of the former. The study indicated that retarded children can be taught word-recognition, simple contextual reading and spelling in a situation nearly free of human intervention. Results reported by Lawson and Watson (1964) confirm, in

part, the efficacy of the teaching machine, programmed instruction approach for helping mentally retarded children learn and retain simple reading skills. They found that as a group, mentally retarded children retained approximately 85% of the new words they had learned via teaching machines over a three month period.

Greene (1966) cites a study by Hewett, et. al., (1965) that a one year experimental program, designed to teach a 250 word basic sight vocabulary to 25 mentally retarded or severely disturbed children, using a programmed teaching machine was successful in bringing non-reading exceptional children up to the first grade level.

Malpass (1970) found that programmed instruction in reading skills using a Mast Teaching Machine produced a greater increase in learning than conventional classroom procedures, and that a large percentage of the learned skills were retained.

From these studies it seems that programmed instruction is relatively effective as an instructional technique for mentally retarded children. Stolurow (1965) relates programmed instruction to computer assisted instruction. During programmed instruction the student works at his own pace on a linear program on a "cheatproof" machine. However: (1) The instructional sequence is not truly individualized since the stimulus is not dependent upon his responses, and (2) Current techniques of frame writing lead to redundancy; consequently exact knowledge of results is seldom needed by the student, leading some observers to discount the importance of reinforcement.

II. Computer assisted instruction with young children.

The true individualization of instruction represents the real departure of computer assisted instruction from programmed instruction. Atkinson (1967), at Stanford, has used drill and practice methods of computer assisted instruction for early vocabulary and spelling instruction with normal children. Children interact with the computer by filling in letters or words presented by drill programs and repetition of the newly acquired words. Data is kept on each child's daily performance and each lesson's format is contingent on the child's performance on the prior lesson.

The PLATO system at the University of Illinois has several programs that can be used to teach vocabulary and spelling to young children. These programs make use of the audio attachments and touch sensitive capabilities of the display screen on the system's newly developed terminal units. In Chicago (Bond, 1972), at various grade levels, over 540 achievement retarded children (at least two years behind) are drilled on arithmetic, language arts, and reading for ten minutes each day. Preliminary evaluations have shown large gains on reading grade level equivalency scores after only a few months on the system.

It can be seen from this review that there is an obvious need for more information on the use of computer assisted instructional techniques with mentally retarded children.

Method

Overview

A two by two experimental design was used for this evaluation. One group of mentally retarded children and one group of normal children participated in the programmed vocabulary sequence and subsequently received a posttest. Control groups of mentally retarded and normal children, judged professionally to be relatively equivalent in mental age range and developmental level, received only the posttest.

Subjects

Subjects for the mentally retarded and normal groups were chosen from classes conducted by cooperating teachers and each student was judged by his teacher as to whether or not he knew 50% or more of the words included in the vocabulary sequence. There were approximately twelve subjects in both the mentally retarded group and the normal group. Each group was divided evenly between experimental and control groups. Subjects' mental ages averaged around the first grade level.

Vocabulary Selection

Words used in this study were chosen from the 300 most frequently occurring English non nouns. One of the criteria for the choice of each word was its suitability in terms of a child's use of it in everyday communication. Words were presented one by one initially, but when a sufficient number had been presented to form a meaningful phrase or sentence they were presented as such for the child to learn. In this manner frequently appearing phrases and sentences were included in each child's repertoire of recognizable and reproducible letter and word configurations.

Terminals

In this experiment standard keyboard type terminals with telephone hookups to the computer were used. The terminals were basically electronically controlled typewriters which accepted input and responded as indicated by the controlling program. The platen areas were fitted with a mask which was placed so that previously typed information was hidden when the paper was advanced approximately five lines from the typing point. The child's typed responses were made exactly as they would be if he was sitting at a regular typewriter. The only major procedural difference was that the carriage return button not only caused the carriage to return, but also signaled the computer that the student's response was completed. It was necessary for the experimenter to perform initial program loading operations, but, beyond that, the terminal instructions were easily handled by the student.

Programs

Standard programmed instruction techniques were used in preparing the introductory and vocabulary sequence. The introductory sequence was designed to familiarize the student with the terminal and stimulus, and feedback statements were of a similar nature to those used in the vocabulary sequence. The introductory sequence, which was written in APL and supported by an IBM computer, lead the student through a set of steps designed to teach him to enter his name, correctly spelled, when requested by the computer. Statistics on the time necessary to complete the sequence and error rate were recorded.

The vocabulary sequence which was written in EXPER, a tutorial language used on General Electric computers, initially presents pronouns, simple conjunctions, and verbs. Combinations of these words are introduced for the student to learn after he has mastered the words that make up the sentence or phrase. The presentation method occurred in basically five steps: (1) the word or phrase was typed by the program on the terminal, (2) the child attempted to reproduce it on the terminal, if this was done correctly, the program branched to the fifth step, (3) the child was presented with the word or phrase with segments of it left blank. This was cued at the side on the same line with the entire word or phrase typed in its entirety, (4) the child reproduced the word or phrase, filling in the missing letters or words. If this response was correct he went on to the next segmented version step, if incorrect he repeated the frame until a correct response was made. After completing correctly all the frames, using segmented versions of the word or phrase, the child went to the last step. (5) The child was asked to type the word or phrase he had been drilling on, and the paper was immediately advanced so that the previously typed responses were hidden behind the mask; thus the student had to reproduce the word from memory. Statistics on time through the sequence, and errors on initial presentation frames and drill frames, were recorded.

The posttest administration followed basically the same presentation scheme as the vocabulary drill. The child sat at the terminal

which has been turned to local mode to enable the student to use it like a regular typewriter. The words that the student worked with in the drill were displayed one by one to him on cards. He was allowed 15 seconds to observe the word and type as much as he could, and 45 seconds more with the word hidden to finish typing it. Statistics were gathered on error rate and time necessary to complete the posttest.

Experimental Method

A data sheet was prepared for each student which included information on mental age, chronological age, mentally retarded or not, and the teacher's judgement on previous knowledge of the vocabulary words in the experimental sequence.

Subjects entered the terminal room one by one and an identifying number was assigned to their data sheet. The subject then completed the introductory sequence with procedural explanation from the experimenter when necessary. The subject was allowed to keep his output from the sequence. Depending on scheduling, the subject either returned to his class, or worked on the vocabulary sequence if he was in the experimental group. Control group subjects completed the posttest after finishing the introductory sequence. For experimental students, the vocabulary module is approximately 20 minutes long. This was found by Malpass (1963) to be the optimal time for instruction with this age level. After completing the vocabulary sequence the experimental subjects were given the posttest.

Hypotheses

The following hypotheses were considered in this study:

1. After completing the introductory sequence and programmed vocabulary sequence there will be no significant (Alpha = .25) difference between the learning of the normal and mentally retarded children, of comparable mental ages, as measured by scores on the posttest.
2. There will be a significant difference between the normal and mentally retarded children when scores have been adjusted for mental age, in terms of error rate on the vocabulary sequence. (Alpha - .05)
3. There will be a significant (Alpha - .05) difference between the normal and mentally retarded children, when scores have been adjusted for mental age, in terms of the time necessary for the completion of the programmed vocabulary sequence.
4. There will be a significant (Alpha = .05) difference between mentally retarded subjects with difference mental ages in terms of learning as measured by posttest scores after completing the vocabulary sequence.
5. There will be a significant difference (Alpha = .05) between mentally retarded subjects with different mental ages in terms of error rate on the vocabulary sequence.
6. There will be a significant (Alpha = .05) difference between mentally retarded subjects with different mental ages in terms

of time necessary for completion of the programmed vocabulary sequence.

7. There will be a significant (Alpha = .05) difference between the posttest socres of experimental subjects and control subjects.

Statistical Treatments

Data was analyzed using BMD statistical programs. In the first hypothesis the alpha level was set to .25 to avoid a Type II error. That is, it was acceptable to say that there existed a significant difference when one did not exist in order to protect against saying that there did not exist a significant difference when one did exist. In this situation, and assuming a low number of subjects, Kirk (1968) suggests the .25 alpha level. For the first three hypotheses, an analysis of variance was performed using mental age as a covariate. The fourth, fifth, and sixth hypotheses were evaluated using regression analyses. The seventh hypothesis was evaluated with a t-test.

Results

The following null hypotheses were investigated:

1. After completing the introductory sequence and programmed vocabulary sequence there will be a significant (Alpha = .25) difference between the learning of the normal and mentally retarded children of comparable mental ages as measured by scores on the posttest.
2. There will be no significant difference between the normal and mentally retarded children when scores have been adjusted for mental age, in terms of error rate on the vocabulary sequence. (Alpha = .05)

3. There will be no significant (Alpha = .05) difference between the normal and mentally retarded children, when scores have been adjusted for mental age, in terms of the time necessary for the completion of the programmed vocabulary sequence.
4. There will be no significant (Alpha = .05) difference between mentally retarded subjects with different mental ages, in terms of learning as measured by posttest scores, after completing the vocabulary sequence.
5. There will be no significant difference (Alpha = .05) between mentally retarded subjects with different mental ages in terms of error rate on the vocabulary sequence.
6. There will be no significant (Alpha = .05) difference between mentally retarded subjects with different ages in terms of time necessary for completion of the programmed vocabulary sequence.
7. There will be no significant (Alpha = .05) difference between the posttest scores of experimental subjects and control subjects.

Analysis of Results

Data involved in the first three hypotheses was analyzed using BMDX64 statistical program with mental age as a covariate.

The null hypothesis was not rejected for the first hypothesis. The F-ratio was 0.09304 which was not significant at the .25 level. This indicates that there was no significant difference between the learning of the normal and mentally retarded children of comparable mental ages, as measured by scores on the posttest.

The second null hypothesis was supported with an F-ratio of 4.09836. This was not significant at the .05 level but was significant at the .10 level. It appears that there is no significant difference between the normal and mentally retarded children, when scores have been adjusted for mental age, in terms of error rate on the vocabulary sequence when Alpha = .05.

The third hypothesis was also not rejected with an F-ratio of 9.54912 which only reaches significance at the .50 level. Thus, there is no significant difference between mentally retarded subjects and normal subjects, when scores have been adjusted for mental age, in terms of the time necessary for the completion of the programmed vocabulary sequence.

The next three hypotheses were investigated using BMD02R, which gave summary statistics and correlations between the two variables under consideration in each hypothesis.

The fourth null hypothesis was not supported. There was a significant (Alpha = .05 with 4 d.f.) negative correlation (r=-0.869) between mental age and errors on the posttest in the mentally retarded group who were in the experimental condition.

The fifth null hypothesis was supported with the correlation coefficient of 0.284 being not significant. This indicates that there is not a relationship between errors on the vocabulary sequence and mental age in the mentally retarded experimental group.

The sixth null hypothesis was also supported with a correlation of -0.479 not being significant. Thus, it appears that there is no significant relationship between time on the vocabulary sequence and mental age in the mentally retarded experimental group.

The seventh null hypothesis was rejected. A t-test was performed yielding t=3.369 which is significant at the .01 level with 10 degrees of freedom. This indicates that the scores of the experimental subjects on the posttest were significantly different from those of the control subjects.

Discussion of Results

The difference in the first hypothesis was probably related to the fact that the normal children were in the final month of kindergarten, whereas the mentally retarded children were in the final month of first grade. The mentally retarded group had had reading instruction for a year and their posttest scores on the average were better than those of the normal group. The large differences in reading level may, however, have been minimized to some extent by the fact that the mentally retarded group had been taught reading by the DISTAR method which at their level, had not yet introduced capital letters. Since the terminals that the children used printed only capital letters, the advantage the mentally retarded children had over the normal children was based on their ability to generalize their reading knowledge of words made up of small letters to words made up of capital letters. Observation indicated that this generalization occurred fairly easily to most of the students.

Thus, it seems that the difference in reading levels produced an intervening variable in the experiment, which should in future experiments be more closely controlled.

Although there was no significant difference between the mentally retarded and normal children in terms of error rate on the vocabulary sequence, inspection of the data shows that the mentally retarded group made roughly four times as many errors as the normal children. Although this doesn't reach statistical significance at Alpha = .05 it does seem to indicate some factor affecting the performance of the two groups of children. Among the mentally retarded group, there was no significant relation between mental age and error rate on the vocabulary sequence. Two factors which might effect these findings are individual levels of perserverance and/or frustration, and experimental conditions such as the effect of the presence or absence of the experimenter.

The non-significant results of tests using the time variable can probably be attributed to experimental conditions. A limit of 30 minutes was put on the vocabulary sequence in order to be able to run the full number of subjects in a somewhat limited time period. Thus, many of the children had their times recorded as 30 minutes which did not reflect where in the vocabulary sequence they actually were when they stopped. The posttest scores are a fairly accurate indicator of how far the children got in the sequence since they almost invariably missed words that they had not been exposed to in the vocabulary sequence.

The rejection of the seventh hypothesis indicates that the vocabulary sequence was valuable in teaching the recognition and reproduction of frequently used vocabulary words to mentally retarded children.

Research during more extended time periods and involving retention tests is necessary. Also, the subjects in the present study were concluding the school year and were at different reading levels. A more valid study could be done using children just entering the first grade and this situation would also provide data on how the performance of children using the sequence compares to children being taught by traditional methods. Sequences could be constructed using audio devices which would aid the children in reading the letter and word combinations. Innumerable elaborations could be built into sequences of this sort using more sophisticated terminal than those employed in this study. It seems to the researcher that the most fruitful areas of investigation lie in this area.